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(54) CURABLE COMPOSITION

(57)Abstract:

PURPOSE: To obtain a curable composition having low hardness and low tack and excellent particularly in staining resistance and also in workability and storage stability by mixing a polyether containing reactive silyl groups with a specified polyether compound as a plasticizer.

CONSTITUTION: This composition comprises 100 pts.wt. polyether containing at least one reactive silyl group of formula I (wherein R1 is a 1-20C alkyl or a 1-20C haloalkyl; Z is a hydrolyzable group; and a is 1-3) and 5-150 pts.wt. polyether compound of formula II (wherein R2 is a 1-8C alkyl; or a 1-12C aryl; X is -O-, -COO-, -OCO- or -S-; m is 15-450; and n is 0-2). This composition has low hardness and low tack and excels particularly in staining resistance and also in workability and storage stability.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention has the resistance to contamination which was especially excellent in the former about the hardenability constituent which has the low degree-of-hardness nature and low tuck nature which were not expected, and by which reforming was carried out, and relates to the hardenability constituent excellent in workability and preservation stability.

[0002]

[Description of the Prior Art] Generally the polyether which has at least one reactant silyl radical in intramolecular is used together with a plasticizer in many cases, although a hardened material employs efficiently the description of having rubber elasticity and is used for applications, such as a coating agent and a sealing agent.

[0003]

[Problem(s) to be Solved by the Invention] However, when a low-molecular-weight plasticizer like the dioctyl phthalate usually used is used, the shift to the front face of a plasticizer is not avoided, but there is a problem that contamination occurs on a hardened material front face or a coating front face.

[0004] The approach of using a polyether compound as an amount plasticizer of macromolecules is proposed (refer to JP,1-279958,A official report). Although a polyether compound is excellent in compatibility with a reactant silyl radical content polyether, and does not have the fall of the reinforcement of a hardened material, either and its plasticizing efficiency is also high, in order to realize the target hardness, when it is used in large quantities, a surface tuck is remarkably generated like the above-mentioned low-molecular-weight plasticizer, a problem is in stain resistance, and a limitation is in the amount used.

[0005] And generally the polyether compound usually has the hydroxyl group at the end, reacts with the reactant silyl radical in a reactant silyl radical content polyether, produces problems, such as thickening / hardening delay and a fall on the strength, and has a problem practically. This is remarkable especially in 1 liquid constituent with which a curing catalyst lives together.

[0006] Although it is also possible to change the hydroxyl group of the end of a polyether compound into ether linkage, a urethane bond, an ester bond, carbonate association, etc. in order to solve this problem, it becomes complicated on a process in this case, and there is an economy top problem practically again. Moreover, reactivity with the reactant silyl radical under catalyst existence becomes high depending on a functional group and is not more desirable than a hydroxyl group. This inclination is remarkable in an aliphatic series ester bond.

[0007] Moreover, the method of attaining plasticization is proposed by adding the compound which reacts to intramolecular with the compound or moisture which has one silanol group, and can generate a silanol group, making it react with it and a reactant silyl radical, and decreasing the number of the points of a hardened material constructing a bridge (refer to JP,61-34066,A). However, when the number of the points constructing a bridge decreases, there is a problem that the reinforcement of a hardened material falls.

[0008] Moreover, in JP,64-9268,A, the compound which has alcohol residue or weak acid residue, and can generate a silanol group is proposed.

[0009]

[Means for Solving the Problem] This invention is invention of the following related with the hardenability constituent made in order to solve the above-mentioned trouble. namely, -- the following -- a general formula -- (-- one --) -- being shown -- having -- reactivity -- silyl -- a radical -- one -- a piece -- - more than -- containing -- silyl -- a radical -- content -- a polyether -- (-- A --) -- 100 -- weight -- the section -- and -- the following -- a general formula -- (-- two --) -- being shown -- having -- a polyether -- - a compound -- (-- B --) -- five - 150 -- weight -- the section -- from -- becoming -- hardenability -- a constituent -- it is .

- SiZa R13-a (1)

(It corrects, it sets to (1) and R1 is the alkyl group of carbon numbers 1-20, or the halo alkyl group of carbon numbers 1-20.) Z is a hydrolysis nature machine. a is the integer of 1-3.

R2-X-(R3-O) m-[SiR42-O] n-SiR53 (2)

(However setting to (2). R2 the alkyl group of carbon numbers 1-8.) R3 The alkylene group of carbon numbers 2-18, or halo alkylene group of carbon numbers 2-18. R4 the alkyl group of carbon numbers 1-12, or the aryl group of carbon numbers 1-12 -- it is -- every -- R4 You may differ mutually. R5 the alkyl group of carbon numbers 1-12, or the aryl group of carbon numbers 1-12 -- it is -- every -- R5 You may differ mutually. X is -O-, -COO-, -OCO-, or -S - m is the integer of 15-450. n is the integer of 0-2.

[0010] By using as a plasticizer the polyether compound (B) which contains a trialkylsilyl group or a thoria reel silyl radical at the end, and does not have a hydroxyl group as a result of inquiring wholeheartedly, this invention persons found out that the hardenability constituent which has low degree-of-hardness nature and low tuck nature, and the hardenability constituent has the especially excellent resistance to contamination and hardening delay excelled [constituent] in little workability could be offered cheaply, and reached this invention.

[0011] As for the polyether compound (B) used for this invention, it is desirable to make the silicon compound shown by the polyether mono-oar shown by the following general formula (3) obtained by making with a carbon numbers of three or more mono-epoxide react to a univalent active hydrogen content compound and the following general formula (4) react, and to obtain.

R2-X-(R3-O) m-H (3)

(However setting to (3). R2 the alkyl group of carbon numbers 1-8.) R3 The alkylene group of carbon numbers 2-18, or halo alkylene group of carbon numbers 2-18. X is -O-, -COO-, -OCO-, or -S - m is the integer of 15-450.

R53Si-[O-SiR42] n-Y (4)

(4) -- setting -- R4 -- the alkyl group of carbon numbers 1-12, or the aryl group of carbon numbers 1-12 - it is -- every -- R4 may differ mutually. [however,] R5 the alkyl group of carbon numbers 1-12, or the aryl group of carbon numbers 1-12 -- it is -- every -- R5 You may differ mutually. Y is a halogen atom. n is the integer of 0-2.

[0012] In the manufacture approach of the polyether mono-oar shown by the general formula (3), a catalyst is usually required. A catalyst well-known as a catalyst can be used. Specifically, alkali metal, such as KOH, a compound metalocyanide complex, etc. are mentioned. When molecular weight exceeds 3000, especially the thing for which a compound metalocyanide complex is used is desirable.

[0013] It is well-known to compound a polyether using a compound metalocyanide complex. This catalyst is indicated by the following United States patent, for example.

USP 3278457, USP 3278458, USP 3278459USP 3427256, USP 3427334, USP 3427335USP 3538043, USP 3829505, USP 3941849USP 4355188, USP 4472560, and USP 4721818 [0014] It is thought that a compound metalocyanide complex has the structure of the following general formula (5) as shown in the above-mentioned well-known example.

M1g[M2x(CN) y] b(H2 O) c Ld (5)

However, M1 Zn (II), Fe (II), and Fe (III), Co (II), nickel (II), aluminum (III), Sr (II), Mn (II), Cr (III), Cu (II), Sn (II), Pb (II), Mo (IV), It is Mo (VI), W (IV), W (VI), etc., and is M2. Fe (II), Fe (III), Co (II),

Co (III), Cr (II), Cr (III), Mn (II), Mn (III), nickel (II), V (IV), and V (V) etc. -- it is -- L is an organic ligand, g, bx, and y are positive integers which change with a metaled valence and the metaled coordination number, and c and d are positive numbers which change with the metaled coordination number.

[0015] M1 in a general formula (5) Zn (II) -- desirable -- M2 Fe (II), Fe (III), Co (II), and Co (III) etc. -- it is desirable. As an organic ligand, there are a ketone, the ether, an aldehyde, ester, alcohol, an amide, etc., for example.

[0016] The compound metalocyanide complex shown by the general formula (5) is metal salt M1 Qg (M 1 is the same as that of ****). Q is M1 [M2x(CN) y] f (M2, x, and y are the same as that of ****). Anion which forms a salt. The poly cyano meta rate Pe (salt) P is hydrogen, alkali metal, alkaline earth metal, etc. e and f are P and M2. Positive integer decided by the valence and the coordination number. After mixing each water solution or solution of the mixed solvent of water and an organic solvent and contacting an organic ligand L to the obtained compound metalocyanide, it is manufactured by removing an excessive solvent and an excessive organic ligand L.

[0017] The poly cyano meta rate Pe (salt) [M2x(CN) y] f Although various metals including hydrogen or alkali metal can be used for P, lithium salt, sodium salt, potassium salt, magnesium salt, and a calcium salt are desirable. It is the especially desirable usual alkali-metal salt, i.e., sodium salt and potassium salt.

[0018] As a univalent active hydrogen content compound used as an initiator, there is a univalent active hydrogen content compound of the univalent carboxylic acid of the univalent phenol of the monohydric alcohol of saturation or partial saturation, saturation, or partial saturation, saturation, or partial saturation, saturation, such as a univalent thiol of partial saturation, or partial saturation.

[0019] As with a carbon numbers of three or more mono-epoxide made to react to a univalent active hydrogen content compound in this invention, ** halo alkylene oxide, such as alkylene oxide and epichlorohydrin, glycidyl ether, glycidyl ester, etc. are mentioned, for example. Desirable mono-epoxide is ethylene oxide, propylene oxide, 1, 2-butylene oxide, isobutylene oxide, 2, 3-butylene oxide, styrene oxide, and other alkylene oxide, and especially its propylene oxide is desirable. Two or more sorts of these mono-epoxide can be used together, respectively.

[0020] As a silicon compound shown by the general formula (4), chloro trimethylsilane, a chloro triethyl silane, a chloro triphenyl silane, etc. are mentioned, for example. Especially a chloromethyl silane is desirable.

[0021] As for a polyether compound (B), it is desirable that molecular weight is 2500-25000, and especially 2500-6000 are desirable. When molecular weight is less than 2500, the resistance to contamination of the hardenability constituent with which the effectiveness as an amount plasticizer of macromolecules with the polyether mono-oar generated from a polyether compound (B) is lost, and plasticizing efficiency is also acquired low is not enough, either, so that it may explain below. Moreover, in exceeding 25000, viscosity becomes high and workability gets remarkably bad.

[0022] Since a polyether compound (B) has the structure which the polyether mono-oar shown by the silicon compound shown by the general formula (4) and the general formula (3) is made to react, and is acquired and does not have the structure which this silicon compound, polyhydric alcohol, or polyether polyol is made to react, and is acquired, it does not have a hydroxyl group. Therefore, there is no possibility that a polyether compound (B) may cause a silyl radical content polyether (A) and a reaction under the nonexistence of moisture.

[0023] On the other hand, under existence of moisture, a polyether compound (B) reacts with moisture and it is thought that the compound which has the silanol group shown by the polyether mono-oar shown by the general formula (3) and the general formula (6) is generated.

R2-X-(R3-O) m-H (3)

(R2, R3, X, and m are the same as the above.)

R53Si-[O-SiR42] n-OH (6)

(R4, R5, and n are the same as the above.)

[0024] The compound which has a silanol group, and the compound which has a silanol group under

coexistence of polyether mono-oar react with the reactant silyl radical in a silyl radical content polyether (A), and the number of the points at the time of a silyl radical content polyether (A) hardening constructing a bridge is decreased. On the other hand, generation polyether mono-oar has little possibility of reacting with work and a silyl radical content polyether (A) only as an amount plasticizer of macromolecules. And it is thought that plasticization is attained by two of generation of reduction of these bridge formation mark and the amount plasticizer of macromolecules.

[0025] The silyl radical content polyether (A) in this invention has one or more reactant silyl radicals shown by the general formula (1) in 1 molecule, it is the polymer with which a principal chain consists of a polyether chain substantially, for example, is the polymer proposed by JP,3-43449,A, JP,3-47825,A, JP,3-72527,A, JP,3-79627,A, JP,46-30711,B, JP,45-36319,B, and JP,46-17553,B, and the process of such a polymer is shown in the above-mentioned reference.

[0026] As for a silyl radical content polyether (A), what a principal chain becomes from polyoxyalkylene like a polyether compound (B) is desirable. A reactant silyl radical is introduced into the end of the polyoxyalkylene compound which has a functional group, for example as such a compound, and it is manufactured.

[0027] The polyoxyalkylene compound which has this functional group has the desirable thing of the hydroxyl-group end which with a carbon numbers of three or more mono-epoxide is made to react to univalent or a multiple-valued active hydrogen content compound, and is manufactured under existence of the catalyst same with using it, in case a polyether compound (B) is manufactured. As for the number of functional groups of this polyoxyalkylene compound, two or more are desirable, and 2-4 are especially desirable.

[0028] With a carbon numbers of three or more mono-epoxide can use said illustrated thing and the same thing. They may be used independently or may be used two or more sorts.

[0029] Polyoxypropylene diol and polyoxypropylene triol can be illustrated as a polyoxyalkylene compound which has this functional group. Moreover, when using for the approach of the following (b) or (d), the polyoxyalkylene compound of olefin ends, such as allyl compound end polyoxypropylene mono-oar, can also be used.

[0030] The reactant silyl radical in this invention is shown by the following general formula (1).

- SiZa R13-a (1)

[0031] Inside R1 of a formula It is the alkyl group of carbon numbers 1-20, or the halo alkyl group of carbon numbers 1-20, and they are a with a carbon number of eight or less alkyl group, a phenyl group, or a fluoro alkyl group especially. They are a methyl group, an ethyl group, a propyl group, a propenyl radical, butyl, a hexyl group, a cyclohexyl radical, a phenyl group, etc. especially preferably.

[0032] Z is a hydrolysis nature machine, for example, has a halogen atom, an alkoxy group, an acyloxy radical, an amide group, the amino group, an amino oxy-radical, a KETOKISHI mate radical, an acid-amide radical, a hydride radical, etc.

[0033] As for the carbon number of the hydrolysis nature machine which has a carbon atom among these, six or less are desirable, and four especially or less are desirable. A desirable hydrolysis nature machine can illustrate a with a carbon number of four or less lower alkoxy group especially a methoxy group and an ethoxy radical, a propoxy group, a propenyloxy radical, etc. a is 1, 2, or 3 and it is desirable that it is especially 2 or 3.

[0034] Although the approach of the installation to the polyoxyalkylene compound of the reactant silyl radical shown by the general formula (1) is not limited, it can be introduced, for example by the following approaches.

[0035] (b) The approach to which the hydrosilyl compound shown by what introduced the olefin radical into the end of the polyoxyalkylene compound which has a functional group, and the general formula (7) is made to react.

HSiZa R13-a (7)

(The inside R1 of a formula, Z, and a are the same as the above.)

[0036] The compound which has a partial saturation radical and a functional group like allyl compound isocyanate or allyl compound chloride is made to react to the end hydroxyl group of polyoxyalkylene

polyol as an approach of introducing an olefin radical here, and in case the polymerization of the approach of combining by ether linkage, the urethane bond, the ester bond, carbonate association, etc. or the alkylene oxide is carried out, the approach of introducing an olefin radical into a side chain etc. is mentioned by adding and carrying out copolymerization of the olefin radical content epoxy compounds, such as allyl glycidyl ether.

[0037] (b) How to make the compound shown by the general formula (8) react to the end of the polyoxyalkylene compound which has a functional group.

R13-aSiZa-R6 NCO (8)

(The inside R1 of a formula, Z, and a are the same as the above.) R6 Alkylene group of carbon numbers 1-17.

[0038] The following compound can show as an organic silicon compound shown by the general formula (8).

(C2 H5 O) 3 Si-(CH2)3-NCO(CH3 O)3 Si-(CH2)3-NCO(CH3 O)2 Si(CH3)-(CH2)3-NCO(CH3 O)3 Si-NCO(CH3 O) 2 Si2 (NCO) [0039] (c) How to make W sets of the silicon compound shown by the general formula (9) react to this isocyanate radical after making the poly isocyanate compounds, such as tolylene diisocyanate, react to the end of the polyoxyalkylene compound which has a functional group and considering as an isocyanate radical end.

[0040] R13-aSiZa-R6 W (9)

(The inside R1 of a formula, R6, Z, and a are the same as the above.) W is the active hydrogen content radical chosen from a hydroxyl group, a carboxyl group, a sulfhydryl group, and the amino group (the 1st class or the 2nd class).

[0041] (d) The approach to which introduce an olefin radical into the end of the polyoxyalkylene compound which has a functional group, and the olefin radical and the sulfhydryl group of the silicon compound shown by the general formula (9) whose W is a sulfhydryl group are made to react.

[0042] Especially the molecular weight of the silyl radical content polyether (A) of this invention is not limited. For example, molecular weight can use the compound of 1000-50000. It is molecular weight 6000-50000 preferably. Especially 7000-30000 are desirable.

[0043] this invention -- hardenability -- a constituent -- silyl -- a radical -- content -- a polyether -- (-- A --) -- 100 -- weight -- the section -- and -- a polyether -- a compound -- (-- B --) -- five - 150 -- weight -- the section -- from -- becoming -- a thing -- it is . The hardenability constituent may contain various additives in addition to these 2 component. Hereafter, the additive which can be used is explained.

[0044] The hardening accelerator catalyst which promotes hardening in the hardening reaction of a reactant silyl radical in this invention may be used. As a hardening accelerator catalyst, alkyl titanate, organic silicon titanate, bismuth tris-2-ethylhexoate, octylic acid tin and the metal salt of the carboxylic acid like dibutyltin dilaurate, dibutyl amine-2-ethylhexoate, etc. solve, and can use other acid catalysts and basic catalysts for an amine salt and a list.

[0045] A reinforcing agent, a bulking agent, a thixotropy agent, etc. may be used if needed. If it considers as a reinforcing agent, as carbon black and a bulking agent, organic pigments, such as inorganic pigments, such as ferrous oxide, chromic oxide, and titanium oxide, and a copper phthalocyanine blue, and Phthalocyanine Green, are mentioned, and, specifically, a calcium carbonate, talc, clay, a silica, etc. are mentioned for an organic-acid processing calcium carbonate, hydrogenation castor oil, calcium stearate, zinc stearate, a fatty-acid amide, an impalpable powder silica, etc. to a pigment as a thixotropy agent.

[0046] The hardenability constituent of this invention can be used for a sealing agent, a waterproofing agent, adhesives, a coating agent, etc.

[0047]

[Example] Although an example explains this invention concretely below, this invention is not limited to these examples. The presentation of the raw material used for the example and the example of a comparison is as follows. In addition, the "section" showing an amount says the weight section.

[0048] Polymer A: The polymerization of propylene oxide was performed using the zinc hexa cyano cobaltate catalyst by having made the glycerol into the initiator, and polyoxypropylene triol was

obtained. Allyl compound chloride was added to this and the hydroxyl group of both ends was changed into the allyl group. Subsequently, methyl dimethoxysilane was made to react to the obtained end allyl group content polyoxyalkylene under existence of a platinum catalyst, the allyl group was changed into the methyl dimethoxy silyl radical, and the polymer A of average molecular weight 20000 was obtained.

[0049] By making a plasticizer B-1:n-butanol into an initiator, using the zinc hexa cyano cobaltate catalyst, performed the polymerization of propylene oxide, subsequently the chloro trimethylsilane of equimolar was made to react to an end hydroxyl group, and the polyether compound (plasticizer B-1) of average molecular weight 6000 was obtained.

[0050] Plasticizer B-2: The polyether compound (plasticizer B-2) of average molecular weight 3000 as well as a plasticizer B-1 was obtained.

[0051] By making a plasticizer B-3:n-butanol into an initiator, using the KOH catalyst, performed the polymerization of propylene oxide, subsequently the chloro trimethylsilane of equimolar was made to react to an end hydroxyl group, and the polyether compound (plasticizer B-3) of average molecular weight 1500 was obtained.

[0052] Plasticizer C-1: The polyether compound (plasticizer C-1) of average molecular weight 300 as well as a plasticizer B-3 was obtained.

[0053] The polymerization of propylene oxide was performed using the zinc hexa cyano cobaltate catalyst by having made the plasticizer D-1:n-butanol into the initiator, and the polyether mono-oar (plasticizer D-1) of average molecular weight 6000 was obtained.

[0054] Plasticizer D-2: The polyether mono-oar (plasticizer D-2) of average molecular weight 3000 was obtained like the plasticizer D-1.

[0055] The polymerization of propylene oxide was performed using the KOH catalyst by having made the plasticizer D-3:n-butanol into the initiator, and the polyether mono-oar (plasticizer D-3) of average molecular weight 300 was obtained.

[0056] Viscosity change of Ushiro who left for two weeks what kneaded the 100 sections and the 40 sections of plasticizers B-1 for the [example 1] polymer A at 40 degrees C was seen, and preservation stability was evaluated. The result is shown in Table 1. Next, created the sheet object with a thickness of 2mm after adding the octylic acid tin 0.75 section and the lauryl amine 0.25 section to this compound, it was made to harden for 14 days under 20 degrees C and 65% humidity, and those tractive characteristics (at the time of 50% **** whenever [stress / M50, breaking strength/Tb, and breaking extension], / Eb) were measured. The result is shown in Table 1.

[0057] Preservation stability was evaluated like the example 1 except having changed respectively examples 2-3 and the [examples 1-4 of comparison] plasticizer B-1 into B-2, B-3, C-1, D-1, D-2, and D-3. The sheet object was created like the example 1 and the tractive characteristics of the sheet were evaluated. The result is shown in Table 1.

[0058] Preservation stability and the tractive characteristics of a sheet were evaluated like the example 1 except not adding the [example 5 of comparison] plasticizer. The result is shown in Table 1.

[0059]

[Table 1]

No.	可塑剤	保存安定性 (粘度変化)	M ₅₀ (kg/cm ²)	T _b (kg/cm ²)	E _b (%)
実施例 1	B-1	良好	1. 4	5. 6	3 9 0
2	B-2	良好	1. 2	5. 2	4 1 0
3	B-3	良好	1. 0	5. 1	4 3 0
比較例 1	C-1	良好	表面べたつき多く測定不可		
2	D-1	不良	2. 8	5. 0	3 2 0
3	D-2	不良	2. 6	5. 3	3 4 0
4	D-3	不良	表面べたつき多く測定不可		
5	なし	良好	4. 3	1 0. 9	2 1 0

[0060] The 100 sections were kneaded for the [example 4] polymer A, the 50 sections, the calcium-carbonate 100 section, the phenolic antioxidant 0.25 section, the benzotriazol system ultraviolet ray absorbent 0.25 section, the dibutyltin dilaurate 1 section, and the vinyltriethoxysilane 1 section were kneaded for the plasticizer B-1, the hardenability constituent was created, and the workability and hardening delay were evaluated. Next, the resistance to contamination of the hardened material which made the same hardenability constituent harden the condition for 14 days at 30 more degrees C for 14 days by 20 degrees C was evaluated. The result is shown in Table 2.

[0061] In addition, evaluation of resistance to contamination and hardening delay is based on the following approaches.

Resistance to contamination; viewing estimated, after exposing a hardened material to the outdoors for one month.

O :stain resistance all ** -less O: -- a little -- those with **:dust adhesion with stain resistance, and stain resistance size x:dust adhesion ***** -- many -- stain resistance -- intense [0062] Hardening delay; 50 degrees C estimated the tuck free time of Ushiro's constituent [an initial list / for 30 days].

O : -- O: which hardens completely and does not have stickiness -- although it hardens nearly completely and **:hardening with small stickiness is progressing -- poor x:hardening [0063] with large stickiness Resistance to contamination and hardening delay were evaluated like the example 4 except having changed respectively examples 5-6 and the [examples 5-8 of comparison] plasticizer B-1 into B-2, B-3, C-1, D-1, D-2, and D-3. The result is shown in Table 2.

[0064]

[Table 2]

No.	可塑剤	耐汚染性	硬化遅延
実施例 4	B-1	◎	◎
5	B-2	◎	◎
6	B-3	◎	◎
比較例 5	C-1	×	×
6	D-1	△	○
7	D-2	△	○
8	D-3	×	×

[0065]

[Effect of the Invention] The plasticizer used by this invention is a polyether compound which does not have the hydroxyl group which has a trialkylsilyl group or a thoria reel silyl radical, and since the end hydroxyl group is protected, its preservation stability is good. Since it does not react with the reactant silyl radical in a silyl radical content polyether, it has the resistance to contamination which was extremely excellent compared with the plasticizer which was being used conventionally, and the effectiveness hardening delay excelled [effectiveness] in little workability is demonstrated. This invention has the effectiveness that the hardened material of a low degree of hardness can be obtained, without reducing the reinforcement of a hardened material with this plasticizer.

[Translation done.]